PART II

SCIENTIFIC AND TECHNICAL

ON THE RESPONSE OF ZOOPLANKTON IN AN ELECTRICAL FIELD

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Zooplankton showed directional movement towards the positive electrode in an electrical field till the current continued to flow. Examination of the plankton twentyfour hours after their exposure for one minute to different current densities showed considerable mortality, the percentage of which was more in the case of the larger size groups.

INTRODUCTION

Electrical fishing in ponds and tanks might have possible adverse effects on their plankton population. Threshold current density for galvanotaxis of *Daphnia magna* has been reported to be 0.9δ by previous workers. The anodic movement of these organisms during galvanotaxis also has been observed by them. The present series of experiments were conducted in the laboratory in order to study the percentage of mortality of zooplankton due to exposure to different current densities.

MATERIALS AND METHODS

The apparatus used for studying the effect of electric current on zooplankton consisted of 11 nos of cylindrical jars of 15 l capacity each, containing 10 l of tap water. The electrodes consisted of two rectangular copper plates, 15.5 cm x 8 5 cm size kept immersed in the jars at a distance of 21 cm from each other. 0.7 ml of of zooplankton collected from a tank was introduced into each of the eleven jars. The jars were divided into five groups, two in each leaving one as control. Direct current was used as source of power. The voltage was reduced by a step down transformer and controlled with the help of a rheostat. The input voltage was read on voltmeter on the switch board and the current drawn measured with a mA meter, connected in the circuit. Electrical stimulation was given for one minute in each jar with variable current densities. The only visible immediate effect observed was the attraction and congregation of plankton around the positive

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TABLE I THE EFFECT OF ELECTRICAL FIELD ON ZOO-PLANKTON

Water temp : 28°C Time of exposure 1 min. Vol. of water 10 l.

Expt. No.	Current density in δ	Total population of plankton in nos.	Observations after 24 hours			
			No. of plankton living	Nos. of plankton dead	% of living	% of dead
		Voltage input - 15				
1	3.2	8150	2550	5600	31	69
2	-do-	13400	6900	6500	51.5	48.5
		Voltage input - 24				
1	8	11750	2850	8900	24	76
2	-do-	10850	2650	8200	24.5	75.5
		Voltage input - 35				
1	15.2	19700	4000	15650	21	79
2	-do-	12700	5200	7500	41	59
		Voltage input - 47				
1	19.2	11600	4150	7450	36	64
2	-do-	14100	4900	9200	35	65
		Voltage input - 55				
1	23.2	13650	3700	9950	27	73
2	-do-	15400	3400	12000	23	77
Control	0	15000	8650	5350	64	36

TABLE II PERCENTAGE OF MORTALITY & SURVIVAL OF INDIVIDUAL ZOOPLANKTON AFTER ELECTRICAL TREATMENT

Water temp : 28°C Time of exposure : 1 min. Vol. of water 10 l.

Current density in δ	Voltage in put	Copepod		Cladocerans		Nauplius	
		% of living	% of dead	% of living	% of dead	% of living	% of dead
3.2	15	37	37.5	13	12.5	—	—
-do-	-do-	20	35.5	15.5	14.5	5.5	—
8	24	34	36	7	14	9	—
-do-	-do-	40.5	36.5	5	13	4.5	0.5
15.2	35	30.5	46.5	5.5	3.5	14	—
-do-	-do-	35.5	45.5	8	4.5	6.5	—
19.2	47	39.5	39	10.5	11	—	—
-do-	-do-	41	44	5	6	4	—
23.2	55	44	36	6	14	—	—
-do-	-do-	35.5	41	10.5	9	4	—
Control	0	38.5	44.5	11.5	5.5	—	—

TABLE III THE % MORTALITY OF INDIVIDUAL ZOOPLANKTON AFTER ELECTRICAL TREATMENT IN RELATION TO SIZE

Water temp. 28°C Time of exposure 1 min. Vol. of water 10 l

Current density in δ	Voltage in put	Copepods 1.95–0.75 mm	Copepods 0.74–0.49 mm	Cladocerans 0.82–0.52 mm	Cladocerans 0.51–0.39 mm	Nauplius 0.19 to 0.15 mm
3.2	15	27.5	10	10.5	2	—
-do-	-do-	28	7.5	11.5	3	—
8	24	26	10	12	4	—
-do-	-do-	31.5	5	5	8	5
15.2	35	40	6.5	2	1.5	—
-do-	-do-	30.5	1.5	4	.5	—
19.2	47	31	8	5	6	—
-do-	-do-	38.5	5.5	6	—	—
23.2	55	29.5	6.5	14	—	—
-do-	-do-	32.5	8.5	6.5	.4	4
Control	0	30.5	14	4.5	1	—

TABLE IV THE % OF SURVIVAL OF ZOOPLANKTON AFTER ELECTRICAL TREATMENT

Current density in δ	Voltage in put	Copepods 1.95–0.75 mm	Copepods 0.74–0.49 mm	Cladocerans 0 82–0.52 mm	Cladocerans 0.51–0.39 mm	Nauplius 0.19–0.15 mm
3.2	15	7	30	7	6	—
-do-	-do-	13.5	15.5	12	3.5	5.5
8	24	8	26	4	3	9
-do-	-do-	16	24.5	1	4	4.5
15.2	35	6	24.5	3	2.5	14
-do-	-do-	15.5	20	3.5	5.5	6.5
19.2	47	15	24.5	6	4.5	—
-do-	-do-	-do-	26	4	1	4
23.2	55	10.5	33.5	6	—	—
-do-	-do-	8	27.5	6.5	4	4
Control	0	25	13.5	-do-	5	—

electrode when the current was switched on. The scattered movements of the plankton were converted into directional movement towards the positive electrode for the whole period of flow of the current.

To observe the subsequent effect, they were allowed to stay in the jars for twenty-four hours, after which the dead planktons were separated from the living ones and fixed in formalin for further study. They were analysed both for quantity and different species. Each species was measured for length and the percentages of mortality and survival were calculated.

Results and discussion

Zooplankton showed a directional movement towards the positive electrode so long as they were in the electric field. It was also observed that larger planktons like *cladocerans* and *diaptomus* moved faster to the positive electrodes and con-

gregrated around them, while the smaller ones took longer time for reaching the electrodes. No immediate effect was observed after the electrical field was removed.

The numbers of dead and living planktons were determined after twenty-four hours and their percentages calculated for different current densities. (Table I). It was observed that dead planktons were more than the living ones in current densities ranging from 3.2 to 23.2δ, except in one case where the current density was 3.2δ. Increased current density did not show any significant effect on the percentage of mortality. But in the control, survivors were more than the dead. No difference was observed in the percentages of mortality and survival among *copepods*, *cladocerans* and *nauplius* from those of control (Table II). The mortality was found to depend on the size of the organisms irrespective of species (Table III). It varied from 26 to 40% in *copepods* of 1.95 to 0.75 mm length and 5 to 14% in those of 0.74 to 0.49 mm while in *cladocerans* of 0.82 to 0.52 mm it was 2 to 14% and in those of 0.51 to 0.39 mm the figure was 2 to 8%. The percentages of survival increased with decrease in size (Table IV). *Daphnia magna* in an electric field have been reported to show anodic movement by some workers while some others were of opinion that these organisms moved towards the cathod during galvanotaxis. In our experiments we have observed a movement towards the positive electrode as long as the flow of current continued. The faster movement of larger planktons towards the positive electrode was possibly due to the lower voltage gradient required by them to exhibit electrotaxis. As soon as the flow was cut off, the planktons exhibited scattered movement.

Conclusion

Zooplanktons like *copepods* and *cladocerans* exhibited directional movement towards positive electrode in an electric field till the current continued to flow. Exposure to electric field for one minute showed more mortality than survival after 24 hours. Larger sizes showed higher rates of mortality.